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Circular No. 748

April 1946 • Washington, D. C.

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JUDGING MOUNTAIN MEADOW RANGE CONDITION IN EASTERN OREGON AND EASTERN WASHINGTON

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THE IMPORTANCE AND NATURE OF MOUNTAIN MEADOWS

Mountain meadows furnish an important part of the summer-range forage in eastern Oregon and eastern Washington. The moist meadow soils are so highly productive that an acre of mountain meadow has a potential grazing capacity equal to 10 to 15 acres of forested range. Although mountain meadows cover only about 1 to 2 percent of the summer-range area of these two States, potentially they can produce 20 percent of the summer-range forage.

Mountain meadows in eastern Oregon and Washington are valuable for other reasons than the amount of forage they can produce. Their lush, choice forage is often the chief factor that enables stockmen to turn off grass-fat animals. On the greater part of the summer range, forage

tends to cure and toughen by midsummer, while mountain meadows in good condition (fig. 1) support plants that remain green and nutritious considerably longer.



FIGURE 1.—Sheep grazing on a mountain meadow in eastern Oregon.

Cattle tend to congregate on meadows and to utilize their succulent plants much more intensively than the drier, tougher vegetation of adjacent forested ranges. Easy herding conditions and an abundance of palatable forage also make meadows favored spots on sheep range. For these reasons, mountain meadows in Oregon and Washington commonly are key areas on which the condition and grazing intensity of many summer ranges may be judged.

Because the meadows are usually small in area compared with the surrounding forested range, their forage is sometimes regarded as of little importance in the total summer-range forage supply. Often, therefore, the highly palatable vegetation of small meadows on cattle range is sacrificed in order to utilize intensively a much larger acreage of forested range. This type of grazing is not warranted by real values.

Mountain meadows are relatively flat or gently sloping grassland areas that occur near the heads and along the courses of mountain streams. The drainage is usually sluggish, and the soil is very wet in spring, but dries sufficiently to be grazed during summer.

Fully productive meadows produce a dense vegetation. On such meadows, tufted hairgrass¹ is the most abundant plant from the Warner Mountains in southern Oregon to the Cascade Mountains and Okanogan Highlands in northern Washington. It is the dominant species on meadows in the lower edge of the ponderosa pine zone as well as at high elevations. It often occurs in nearly pure stands, and grows in compact bunches. Other common meadow plants are such grasses as thin bentgrass, red fescue, and Kentucky bluegrass; grasslike plants such as Nebraska sedge, water sedge, and Baltic rush; and weeds such as western aster, cinquefoils, leafy arnica, and American bistort.

¹ Common and scientific names of species mentioned in this bulletin are listed on pages 30 to 31.

Mountain meadows are formed in several ways. Usually they develop as lakes or ponds are filled in by silt deposits. The areas are swamps during the early stages of silting-in, but after the soil has been built up sufficiently so that it is no longer waterlogged, the bulrushes, common cattail, and other swamp plants give way to typical meadow vegetation—grasses, sedges, and weeds. The swamp vegetation, however, often remains in low places which are too wet to be grazed readily.

As the soils of wet meadows develop they become drier through the lowering of the water table by drainage, by additional silting-in, and by becoming more porous and better aerated from the development and decay of plant roots. In southeastern Washington, the meadow vegetation ultimately will give way either to a bunchgrass or forest type, depending on the climate that prevails.² It is probable that forests will occupy most places now supporting meadow vegetation in the mountainous summer range. From a range-management standpoint, however, meadow vegetation should not be considered as transitory, since it normally remains unchanged for a long time—perhaps centuries.³

Forage on mountain meadows in good or excellent condition is resistant to fairly heavy grazing because it grows on deep, fertile sub-irrigated soil. Furthermore, the nearly level meadow soil, well protected by vegetation, is not subjected to rapid surface runoff and erosion. Consequently, with proper range management, the vegetation and soil can be maintained in a highly productive condition indefinitely. However, if mountain meadows are overgrazed for a period of years, definite changes take place in the plant cover, the grazing capacity is reduced, and in extreme cases the water table is lowered as eroding stream channels are deepened to such a degree that subirrigation is destroyed.

Many mountain meadows in eastern Oregon and eastern Washington are in a more or less depleted condition. Some are improving; others are losing productiveness. Some are being subjected to excessive erosion and drainage. The additional forage that would be produced from the improvement of mountain meadows not now producing at full capacity, will result in greater production of livestock and livestock products. It is important, therefore, that stockmen and others responsible for the management of summer range be able to recognize the condition and trend of vegetation on mountain meadows in order that proper and timely adjustments in livestock numbers and management may be made.

The Pacific Northwest Forest and Range Experiment Station studied mountain meadows extensively in eastern Oregon and eastern Washington from 1940 to 1942, inclusive. Usable indicators for judging their condition were determined and tested under practical conditions. This publication, which presents general guides by which the condition of mountain meadows can be judged, and tentative standards for determining proper utilization of mountain-meadow vegetation, should be valuable to those who use or manage summer range and who have such meadows not only in the two States but throughout the West.

² WEAVER, J. E. A STUDY OF THE VEGETATION OF SOUTHEASTERN WASHINGTON AND ADJACENT IDAHO. *Nebr. Univ. Studies*, v. 17 (1), 131 pp., illus. Lincoln, Nebr. 1917.

³ BRAUN-BLANQUET, J. PLANT SOCIOLOGY, THE STUDY OF PLANT COMMUNITIES. 439 pp., illus. New York. 1932.

RECOGNIZING RANGE CONDITION OF MOUNTAIN MEADOWS

The kind and amount of vegetation that mountain meadows produce depend upon their productive condition. Those in top condition support a dense, even sod of perennial grasses and sedges with few perennial weeds and practically no annuals. By contrast, severely depleted meadows are usually scantily covered with plants that are chiefly annuals. Meadows partially recovered from severe depletion, or partially depleted from a good condition, have various mixtures of perennial grasses and sedges, perennial weeds, and annuals.

The changes in mountain-meadow vegetation in response to different degrees or systems of grazing use are similar to successional changes observed on other mountain grasslands.⁴ Continued overuse causes the dense sod of perennial grasses and the few good perennial weeds to thin out and allows the less valuable perennial weeds to increase in the bare spots thus provided. As deterioration progresses the perennial weeds more or less completely replace the grasses. Finally, if improper grazing continues, even the perennial weeds are reduced in vigor and abundance, allowing annual grasses and weeds to become established and crowd out the perennials. The thinner the stand of vegetation the less protection is given to the soil, and as erosion progresses the productivity of the soil is more and more reduced. With proper management, grassland ranges, including mountain meadows, will recover, ordinarily retracing the above steps in reverse order.

Major steps or stages in the development or deterioration of grassland vegetation are known as (1) annual weed, (2) perennial weed, (3) mixed grass-and-weed, and (4) perennial grass or climax. They can be easily recognized. In studies on subalpine grassland ranges of Oregon and Washington⁵ these development stages have been found to be directly associated with range forage production and soil stability.

In the course of the study of mountain meadows by the Pacific Northwest Forest and Range Experiment Station the abundance and distribution of range plant species were determined on 37 mountain-meadow areas which were representative of meadows in eastern Oregon and eastern Washington as to plant cover, soils, topography, and other factors. These were found to represent the principal stages of vegetation development or deterioration. Six were meadows in good or excellent condition, supporting mainly perennial grasses and sedges, and in this circular have been grouped under the term "good." They were uninjured or practically so. On 9, classed as in "fair" condition, perennial weeds approximately equaled perennial grasses and sedges in abundance. On 14, in "poor" condition, weeds were the chief vegetation, perennial weeds being more abundant than annuals. Eight were badly depleted meadows ("very poor" condition) that supported little except annual plants. Each meadow was observed closely to find noticeable characteristics that would help identify the stage of vegetational deterioration or recovery.

The average condition of the meadows in each condition class, as well as the principal indicators of the condition classes, are described. It is

⁴ SAMPSON, A. W., PLANT SUCCESSION IN RELATION TO RANGE MANAGEMENT. U. S. Dept. Agr. Bul. 791, 76 pp., illus. 1919.

⁵ PICKFORD, G. D. and REID, E. H. BASIS FOR JUDGING SUBALPINE GRASSLAND RANGES OF OREGON AND WASHINGTON. U. S. Dept. Agr., Cir. 655, 38 pp., illus. 1942.

recognized that *all* indicators of range condition can seldom be found on a single meadow. Plant species and species mixture within each condition class vary from meadow to meadow and from place to place on a single meadow. The same may be said regarding indicators of range trend.

GOOD CONDITION

Mountain meadows in good or excellent condition present the appearance of a dense, even stand of grass, resembling well-sodded hay fields. This is the most obvious indication that range management has effectively maintained forage production (fig. 2). After grazing, the rather



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FIGURE 2.—Mountain meadows in good condition are evenly and densely grassed, chiefly with tufted hairgrass. On this grazed meadow 80 percent of the ground surface is covered by vegetation, of which four-fifths is tufted hairgrass. A tough sod formed by the densely interwoven perennial roots gives ample soil protection. Two acres will support a cow for four months' summer grazing.

uniform forage value of plants on such meadows results in their being cropped so evenly that they appear to have been mowed.

Vegetation on the six meadows classified as in good condition covered an average of about 68 percent of the ground surface (table 1). Although this is a high density for range land, one of the meadows was so heavily covered with plants that only 17 percent of the ground surface was bare when viewed directly from above, thus approaching the thickness of cover on the average lawn. Meadow plants, however, are taller than ordinary lawn grasses and therefore produce a greater quantity of leafage.

Perennial grasses, on the average, make up about three-fourths of the total vegetation on meadows in good condition (fig. 3). Annual grasses, annual weeds, and rushes are generally present in such small quantities as to be virtually unnoticed. Sedges normally constitute only 10 to 15 percent of the total plant cover, and perennial weeds less than 10 percent.

Tufted hairgrass is the most abundant plant. It is very conspicuous because of its tall, smooth, shiny flower stalks, growing evenly, and

TABLE 1.—Average density¹ and composition of meadow vegetation by condition class

Species	Good		Fair		Poor		Very poor	
	Density	Composition	Density	Composition	Density	Composition	Density	Composition
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Perennial grasses:								
Bentgrass, thin	0.02	(²)	5.61	11.9	1.07	3.5		
Bentgrass, winter	.23	0.3	.06	.1	.15	.5	(³)	(²)
Bluegrass, Kentucky	.23	.3	1.28	2.9	1.73	5.7	0.05	0.4
Bluegrass, Cusick			.74	1.6	.72	2.4		
Bluegrass, Sandberg					.03	.1	.02	.2
Brome, mountain			(³)	(²)	.01	(²)	.09	.8
Danthonia, California	.07	.1	1.48	3.1	.01	(²)		
Fescue, red	.83	1.2	2.39	5.1	.34	1.1	.02	.2
Hairgrass, slender			.01	(²)	.13	.4	.35	3.0
Hairgrass, tufted	47.18	69.7	8.11	17.1	1.67	5.4	(³)	(²)
Junegrass, prairie			.44	.9	.61	2.0		
Other	1.94	2.9	.58	1.2	1.68	5.5	.11	.9
Total	50.50	74.5	20.80	43.9	8.15	26.6	.64	5.5
Annual grasses:								
Brome, cheatgrass					.01	(²)	.02	.2
Brome, soft							1.40	12.0
Hairgrass, annual					.05	.2	.04	.3
Muhly, pullup	.85	1.2	1.82	3.8	1.19	3.9	1.35	11.6
Total	.85	1.2	1.82	3.8	1.25	4.1	2.81	24.1
Sedges:								
Sedge, Nebraska	1.30	1.9	.69	1.5	.01	(²)		
Other sod-forming species	8.13	12.0	2.34	4.9	1.12	3.7	.01	.1
Tufted species	.05	.1	.56	1.2	1.14	3.7	.11	.9
Total	9.48	14.0	3.59	7.6	2.27	7.4	.12	1.0
Rushes:								
Rush, Baltic	1.40	2.1	1.99	4.2	.44	1.4	.01	.1
Other	.08	.1	.24	.5	.25	.8	.01	.1
Total	1.48	2.2	2.23	4.7	.69	2.2	.02	.2
Perennial weeds:								
Arnica, leafy	.12	.2	.44	.9	.37	1.2	.02	.2
Aster, western	1.92	2.8	4.09	8.7	2.28	7.4	.12	1.0
Bistort, American	.57	.8	.38	.8	.64	2.1	.15	1.3
Cinquefoils	.15	.2	2.94	6.2	2.84	9.3	.27	2.3
Clovers	.50	.7	2.01	4.2	.44	1.4	.04	.3
Dandelion, common	.10	.2	1.00	2.1	1.46	4.8	.58	5.0
Groundsels	.45	.7	3.27	6.9	3.41	11.1	.09	.8
Pussytoes					.11	.4	.31	2.6
Waterleaf							.80	6.9
Yarrow, western	.05	.1	1.46	3.1	2.37	7.7	.71	6.1
Other	1.49	2.2	3.24	6.9	2.97	9.7	.72	6.2
Total	5.35	7.9	18.83	39.8	16.89	55.1	3.81	32.7
Annual weeds:								
Gilia			.01	(²)	.16	.5	.41	3.5
Groundsmokes			(³)	(³)	.11	.4	.28	2.4
Knotweed, Douglas			(³)	(²)	.15	.5	1.46	12.5
Lettuce, prickly							.21	1.8
Tarweeds			.01	(²)	.34	1.1	1.43	12.3
Other	.05	.1	.05	.1	.31	1.0	.45	3.9
Total	.05	.1	.07	.1	1.07	3.5	4.24	36.4
Shrubs	.05	.1	.02	.1	.33	1.1	.01	.1
All species	67.76	100.0	47.36	100.0	30.65	100.0	11.65	100.0

¹ Percent of ground surface covered by vegetation.

² Less than 0.05 percent.

³ Less than 0.005 percent.

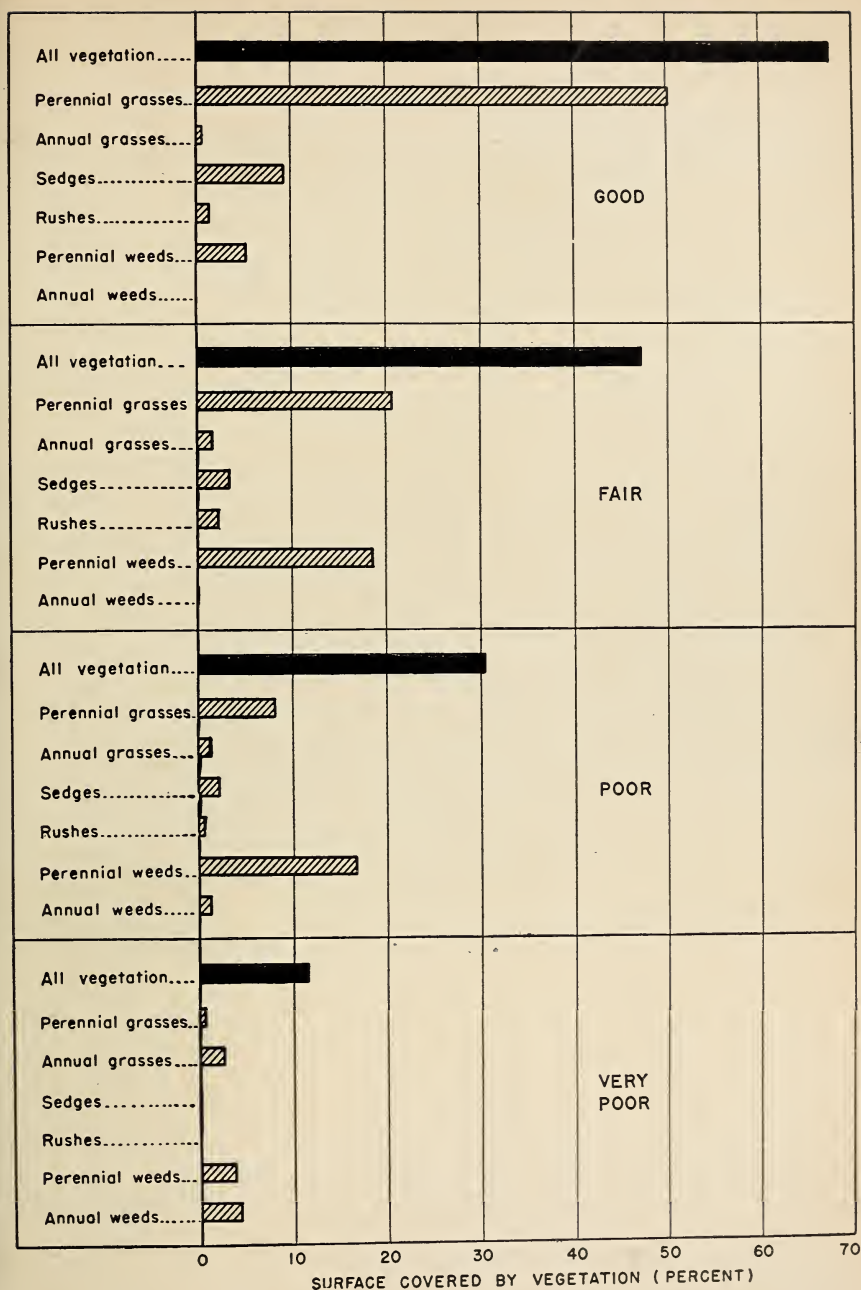


FIGURE 3.—Density of mountain-meadow vegetation in various range-condition classes.

occupying moderately dry as well as very moist situations (fig. 4). Its height and density hide the secondary meadow plants from casual observation. On the six meadows observed, more than two-thirds of the vegetation and nearly 95 percent of the perennial grass stand was tufted hairgrass. Therefore, a meadow which at first glance seems to support a



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FIGURE 4.—Tufted hairgrass in good vigor forms large, dense tufts of basal foliage and has numerous tall, shiny flower stalks. This dense tufted hairgrass stand, screening the sparse weeds, sedges, and secondary grasses, is typical of mountain meadow range in good condition.

dense cover solely of tufted hairgrass on all its area may be safely regarded as in good condition.

Kentucky bluegrass, winter bentgrass, and red fescue are the most common sod-forming secondary grasses on Oregon and Washington meadows in good condition, but these are rarely noticeable in the plant cover since they are scattered thinly amid the dense stands of tufted hairgrass. Altogether, they made up less than 2 percent of the plant cover on the six meadows.

Sedges and rushes, like the secondary grasses, are more or less inconspicuous on meadows in good condition. Usually they are found as weak individuals forming part of the understory to the taller tufts of hairgrass. They grow densely, however, in low, swampy places, which are

often a part of mountain meadows but should not be confused with the meadow proper. Nebraska sedge, a sod-forming plant is ordinarily present on such meadows, and is easily recognized by its distinctive silvery or bluish-green color and its coarse, heavy-ribbed leaves. Tuft-forming sedges, such as ovalhead sedge, however are not common.

Perennial weeds are always found but they are not in dense patches nor as tall as the tufted hairgrass. Hence they are inconspicuous, and meadows in good condition are not particularly colorful when the weeds are in flower. Western aster is usually the most abundant weed and American bistort, cinquefoils, common dandelion, clovers, leafy arnica, western yarrow, and groundsels are also common, but none represents as much as 1 percent of the total vegetation.

Annual grasses and annual weeds, weak, spindly, and widely scattered, are usually found only by close search. Annual grasses are represented chiefly by pullup muhly, a low, moisture-loving grass that grows in the shade of the taller perennials.

The soil on mountain meadows in good condition is rich in organic matter and highly productive. There are no continuous areas of exposed bare soil. Stream courses are sodded to the water's edge. The sod is unbroken on the shoulders of stream banks, and no gullying, sheet erosion, or active stream channeling is taking place.

FAIR CONDITION

Mountain meadows in fair condition present a rather different appearance. They are densely but unevenly covered with vegetation because of the luxuriant perennial weeds. Examination, however, usually reveals a lower plant density than on meadows in good condition. On the nine fair-condition meadows that were observed, density averaged only 47 percent compared with 68 percent for those in good condition (table 1).

Perennial grasses and perennial weeds occur in about equal abundance and are by far the most prominent vegetation on fair-condition meadows (fig. 3, p. 7). Annuals, both weeds and grasses, are sparse. Sedges and rushes each make up only 5 to 8 percent of the total plant cover, although they tend to grow in large, noticeable clumps or colonies.

Tufted hairgrass is still the dominant perennial grass on meadows that have been reduced to a fair range condition, but its average density is only one-sixth of what it is on good-condition meadows. On the nine fair-condition meadows observed, tufted hairgrass made up less than 20 percent of the total plant cover and slightly less than 40 percent of the perennial grass stand. Tufted hairgrass grows in dense, relatively pure stands on some of the remaining moist areas, but on the meadow fringes and slight elevations, where the soil is drier, it is sparse or entirely absent. This patchy growth of tufted hairgrass is an easily recognized characteristic of fair meadow range condition.

Within the dense patches of tufted hairgrass the vegetation is similar to that which uniformly covers meadows in good range condition. Other grasses and weeds cannot compete vigorously with the dense, shady growth of hairgrass. On the drier sites, however, thin bentgrass, Kentucky bluegrass, and, less frequently, red fescue and Cusick bluegrass, are abundant. The last is sometimes the chief secondary grass on meadows in fair condition in the southern Blue and Warner Mountains. In the Cascade Range and Okanogan Highlands, Kentucky bluegrass is

generally the most prominent secondary grass, but over most of the central and northern Blue Mountains, either thin bentgrass or Kentucky bluegrass may be the dominant grass on meadow areas where tufted hairgrass has been thinned.

Kentucky bluegrass, thin bentgrass, and red fescue are all sod-formers and, therefore, promote soil stability. They are also sufficiently palatable to livestock to be regarded as fair to good forage. Cusick bluegrass, a bunchgrass, is also fairly palatable. One or more of these species may sometimes grow abundantly on meadows that have partly recovered, with little or no tufted hairgrass present because its seed source was greatly reduced in the downward process.

Tall bunchgrasses such as meadow barley, timothy, slender wheat-



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FIGURE 5.—The showy, white flower heads of American bistort, intermixed with tufted hairgrass, thin bentgrass, and sedges, are often a conspicuous part of the early summer flora on mountain meadow range in fair condition.

grass, and the smaller slender hairgrass may be present in very small amounts on meadows in fair range condition, and mainly where the tufted hairgrass is thinned but soil moisture is plentiful. On the driest soils, usually devoid of tufted hairgrass, such grasses as California danthonia, prairie junegrass, and mountain brome are prominent.

Sod-forming sedges and rushes are scattered throughout the dense patches or colonies of tufted hairgrass; but just outside these, the sedges and rushes also usually form extensive patches or colonies. The rather large, pure stands of bluish-gray Nebraska sedge, and the dark-green patches of Baltic rush are easily recognized characteristics of fair meadow condition. Bunch-forming sedges, such as ovalhead sedge, grow with prairie junegrass, mountain brome, and other dry-land grasses on the driest, most depleted spots of the meadow.

Scattered perennial weeds growing in the moist areas are generally hidden by the tall, dense tufted hairgrass. However, on the drier meadow

sites, weeds are conspicuous, either in mixture with the secondary grasses and sedges, or in distinct clumps. Western aster and groundsels are generally the most abundant weeds on meadows in fair condition, while cinquefoils, clovers, common dandelion, western yarrow, and leafy arnica are prominent. The showy, white heads of American bistort may also be conspicuous in early summer, especially in the Blue Mountains (fig. 5). During the flowering season, the bright weed blossoms blend with the lush green of meadow grasses to present a pleasant and characteristic landscape.

Such annual weeds as tarweeds and gilies are to be found in small, denuded spots on the driest meadow portions, but annual grasses, except for pullup muhly, are usually absent. The muhly occurs in small amounts on moist sites in most meadows, regardless of their condition.

There is little evidence of accelerated soil erosion or stream channel cutting on meadows in fair condition. The moderately high density of vegetation holds the soil in place and prevents rapid runoff, but the shoulders of stream banks sometimes exhibit loose, unstable soil where livestock congregate or cross streams. Also, soil on the driest spots is sometimes so exposed that it is dusty and erodible. These sore spots are generally so small and well surrounded by stable, well-rooted vegetation that they do not cause serious damage to the meadow.

POOR CONDITION

The amount and nature of vegetation on mountain meadows in poor condition depends to some extent on how much the water table has been lowered by deepened and widened stream courses. The vegetation



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FIGURE 6.—The distinctly patchy appearance resulting from the intermingling of colonies of western yarrow and other weeds with grasses, sedges, and rushes is typical of mountain meadow range in poor condition.

may cover only about one-third of the ground surface (fig. 3, p. 7). There is a strong tendency for plants of the same species to grow in relatively pure clumps or stands on small areas, thus giving such meadows a distinctive patchy appearance (fig. 6).

Perennial weeds, usually comprising more than half of the plant cover, are the outstanding vegetation on poor-condition meadows, but even they are not as abundant as on meadows in fair condition (table 1, p. 6). On the 14 meadows observed that were in poor condition, perennial weeds occupied twice as much ground as the grasses. Sedges and rushes together, in a thin stand, normally make up about 10 percent of all vegetation, while annual grasses and annual weeds are usually negligible and confined to small areas.

Tufted hairgrass may still be found growing in very small, dense patches on the wettest meadow portions, and very sparingly on fairly moist soils, but it is ordinarily absent in dry places. The other prominent perennial grasses include Kentucky bluegrass and thin bentgrass, both of which grow sparingly on moist as well as moderately dry meadow soils. Since they spread by rootstocks, they generally occur in sharply defined clumps on meadows in poor condition.

Some grasses, such as prairie junegrass and mountain brome, are present where drainage is good and the soil rather dry, loose, and loamy. The brome sometimes grows in distinct patches on high banks along stream channels where soil disturbance is evident. Slender wheatgrass and meadow barley are sometimes common.

Sod-forming sedges are found only in wet spots where they form small dense stands that are moderately grazed. Nebraska sedge is usually absent, but tufted species growing in large bunches such as ovalhead sedge, are often conspicuous on dry, badly depleted areas. Clumps or colonies of Baltic rush contribute to the patchy appearance of poor-condition meadows.

On such meadows, Columbia groundsel, western yarrow, cinquefoils, western aster, and common dandelion, usually growing on moderately moist soils, are the most abundant weeds (table 1).

Dense stands of wyethias are likewise an indication of poor condition (fig. 7), along with American bistort, littleflower penstemon, and agoseris in localized, nearly pure stands on fairly dry soils. Sometimes, too, dense clumps of California false-hellebore are found in low, moist spots. In general, dense colonies of perennial weeds are quite conspicuous on poor-condition meadows. Such ranges are extremely colorful at the height of the flowering season.

Pullup muhly and annual hairgrass are the chief annual grasses on poor-condition meadows, while annual weeds, principally Douglas knotweed, giliads, groundsmokes, and tarweeds, although comprising only a small amount of the vegetation, can be found on small, denuded, very dry areas.

There is considerable bare soil which is often loose and worked by rodents, or compacted and deficient in organic matter. The stream banks are usually steep and barren, or thinly covered with short-lived grasses and weeds. Stream channels usually show evidence of active cutting, both in depth and width, thereby draining the adjoining meadow and converting it from a wet to a dry site. Bars formed by silt deposits are common in the streams, and side gullies sometimes eat into the meadow from the main drainage course, thus helping to lower the water table.



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FIGURE 7.—Two kinds of plant cover typical of mountain meadows in poor condition: *A*, Vegetation composed chiefly of cinquefoils, agoseris, groundsels, western yarrow, and American bistort; *B*, dense stands of groundsels and wyethias.

VERY POOR CONDITION

The outstanding characteristics of mountain meadows in very poor condition are sparse plant cover and a preponderance of annual and perennial weeds (fig. 8). Much bare soil is exposed that bakes, cracks,



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FIGURE 8.—A plant cover composed largely of Douglas knotweed, tarweeds, and groundsmokes is typical of badly depleted mountain meadows. The relatively small quantity of herbage produced and its poor forage value result in an extremely low grazing capacity.

and becomes very dusty by midsummer. On the eight depleted meadows studied, vegetation covered barely one-eighth of the ground surface (fig. 3). Annual weeds accounted for over one-third of the total vegetation; annual and perennial weeds together made up over two-thirds. Waterleaf and other succulent weeds are common in the spring, but dry up early in the summer. On most meadows in very poor condition, annual grasses are no more abundant than on meadows in better condition, but because of the scarcity of other range plants seem prominent.

The dominant perennial grass on moist spots is slender hairgrass, nearly worthless as forage. Tufted hairgrass is found occasionally along streams and in very wet places, and some weak plants of red fescue and Kentucky bluegrass may still persist on the drier situations. On moist, badly depleted meadows considerably trampled by livestock, a thin stand of Kentucky bluegrass in mixture with annual bromes may be found. Mountain brome may be present on well-drained sites where soil disturbance occurs, while widely scattered oniongrass plants may grow on "tight" clay or gumbo soils.

Usually the sod-forming sedges have disappeared, but occasional plants of the tufted-sedge species as well as Baltic rush occur.

The most abundant perennial weeds on very poor meadows are common dandelion, cinquefoils, pussytoes, and western yarrow. In the Cascade Mountains of Washington, waterleaf is sometimes abundant. Groundsels, western aster, and leafy arnica are usually present in small quantities.

Among annual weeds on very poor condition meadows, Douglas knotweed and tarweeds are by far the most numerous. Gilias and groundsmokes are also widespread. Of the annual grasses, pullup muhly and annual hairgrass commonly inhabit the moist sites, and soft brome and cheatgrass brome are found in the drier localities. The latter two species may form a major part of the vegetation.



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FIGURE 9.—When stream channeling lowers the water table and destroys sub-irrigation on mountain meadows, big sagebrush and other dry-land vegetation take over.

Soils are ordinarily exposed. They may be loose and worked by rodents, or compacted and lacking in organic matter. Sometimes stream channels have been cut so deeply and side gullies are so extensive as the result of accelerated runoff and erosion that wet meadow conditions no longer exist (fig. 9). Such injured meadows support big sagebrush, cheatgrass brome, subalpine needlegrass, Sandberg bluegrass, and other species typical of dry sites. In fact, this is the end of true-meadow condition and high grazing capacities until the water table can be raised and the meadow species reintroduced. A long period of careful management, and usually the installation of silting dams or water spreading, is required to restore these areas to wet, productive condition.

MEADOW CONDITION DETERMINES GRAZING VALUE

The grazing value of mountain meadows is closely associated with range condition. Both quantity and quality of vegetation affect grazing capacity. Obviously, meadows with a dense stand of palatable grass are much more valuable for livestock grazing than those which produce only a thin cover of weeds.

Relative grazing capacities of meadows in different range condition were determined from studies of grazing values of mountain-meadow vegetation made on selected meadows grazed by both sheep⁶ and cattle.

⁶The sheep used in the grazing tests were furnished through the cooperation of the Oregon State Agricultural Experiment Station, Corvallis, Oreg.

The meadows on which actual grazing of forage plants was intensively studied were typical of many in eastern Oregon and Washington. They all averaged fair condition. Portions supported plants, however, that are abundant on meadows in good condition while other areas, especially the drier borders, supported plants commonly found on depleted ranges in poor or very poor condition. The utilization of the various forage plants was studied for each meadow as a whole. Grazing, whether by sheep or cattle, was reasonably conservative, so as to give the better forage plants a chance to improve, although an effort was made to utilize the forage as closely as possible without injuring the important palatable forage species. The percentage utilization of the different species was determined after the meadow had been grazed. By combining this

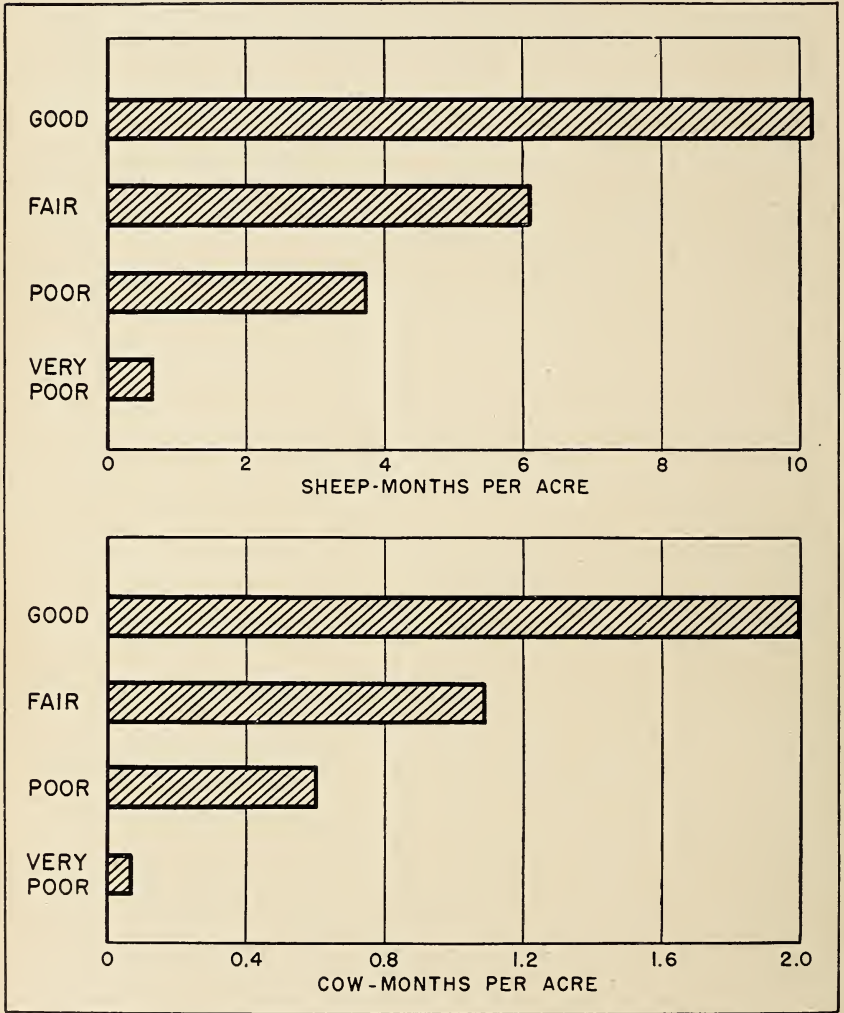


FIGURE 10.—Average grazing value of mountain-meadow vegetation by condition class.

utilization information with the amounts of forage species that occurred on the 37 meadow areas, it was possible to ascertain the relative grazing values of meadows in each range condition class (fig. 10).

Following this procedure, grazing capacity of mountain meadows classed as in good condition was found to average 10.2 sheep months or 2.0 cow months per acre. The high grazing capacity of these productive mountain meadows is emphasized by comparison with grazing values of other range types. Average grazing capacity of forest range in eastern Oregon and eastern Washington was estimated by the Cooperative Western Range Survey to be less than 0.2 cow month per acre and that of foothill grassland range about 0.4 cow month per acre.⁷ The grazing capacity of good-condition meadows is therefore 10 times that of the average forest range, and 5 times that of average grassland range.

A change to poorer condition is accompanied by a serious loss in grazing capacity. The average capacity of meadows in fair condition was 6.2 sheep months or 1.1 cow months per acre; poor condition, 3.8 sheep months or 0.6 cow month per acre; and very poor condition, 0.7 sheep month or less than 0.1 cow month per acre (fig. 10). The grazing values for sheep of fair, poor, and very poor condition meadows averaged 61 percent, 37 percent, and 7 percent, respectively, of meadows in good condition. For cattle, the grazing values of meadows in fair condition average 55 percent, in poor condition 30 percent, and in very poor condition 5 percent of those in good condition.

Losses in grazing value with deterioration of condition are somewhat greater on cattle than on sheep range. This is due to a higher preference of sheep for the perennial weeds that replace the grasses as meadows deteriorate. Indeed, the weeds on the average are only slightly less palatable to sheep than are the original perennial grasses. The differences in grazing values on sheep range, therefore, are due in a large measure not to the different composition of the vegetation but to the reduced amount of herbage produced on the depleted meadows. However, the much lower palatability of perennial weeds to cattle as well as greatly lowered plant densities reduces the grazing capacity of deteriorated meadows for cattle range. The annual weeds and grasses that characterize badly depleted meadows are low in palatability to both cattle and sheep.

Tufted hairgrass furnished about 80 percent of the palatable forage on good-condition meadows (table 2), while on fair-condition meadows it made up only one-fourth of the forage. Even with an extremely reduced stand on poor-condition meadows it still furnishes from 8 to 10 percent of the forage.

It is notable that thin bentgrass and Kentucky bluegrass sometimes become the major forage species on meadows restored to fair condition after having been badly depleted. In Oregon, thin bentgrass is more common in this role, but in eastern Washington, Kentucky bluegrass is more prominent.

As a class, perennial weeds are important as sheep forage on all meadows in fair condition.

Of the more limited forage on meadows in poor condition, the perennial weeds made up 67 percent of that available for sheep, and 46 percent of that for cattle. Kentucky bluegrass ranked closely with tufted hairgrass as a forage producer on poor-condition meadows, furnishing around 10 percent.

⁷ See ACREAGE AND GRAZING CAPACITY OF RANGE LANDS IN OREGON AND WASHINGTON, Pacific Northwest Forest and Range Expt. Sta., Portland, Oreg. 1940. [Processed.]

TABLE 2.—Average composition of sheep and cattle forage by meadow-condition class

Species	Good		Fair		Poor		Very poor	
	Sheep	Cattle	Sheep	Cattle	Sheep	Cattle	Sheep	Cattle
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Perennial grasses:								
Bentgrass, thin.....	(1)	(1)	6	13	2	4	-----	-----
Bluegrass, Kentucky.....	(1)	(1)	4	5	8	11	1	3
Bluegrass, Cusick.....			1	2	2	3		
Bluegrass, Sandberg.....					(1)	(1)	(1)	(1)
Brome, mountain.....			(1)	(1)	(1)	(1)	1	4
Danthonia, California.....	(1)	(1)	3	6	1	1	-----	-----
Fescue, red.....	1	1	4	4	1	0	(1)	1
Hairgrass, slender.....			(1)	0	(1)	0	1	0
Hairgrass, tufted.....	79	80	23	26	8	10	(1)	(1)
Junegrass, prairie.....			1	2	2	3		
Other.....	2	4	(1)	2	3	9	2	6
Total.....	82	85	42	57	26	41	5	14
Annual grasses:								
Brome, cheatgrass.....					(1)	(1)	(1)	(1)
Brome, soft.....							3	7
Hairgrass, annual.....					0	0	0	0
Muhly, pululp.....	(1)	(1)	(1)	(1)	(1)	1	3	7
Total.....	(1)	(1)	(1)	(1)	(1)	1	6	14
Sedges:								
Sedge, Nebraska.....	2	2	2	2	(1)	(1)	-----	-----
Other sod-forming species.....	8	10	3	6	1	5	(1)	(1)
Tufted species.....	(1)	(1)	1	1	4	5	2	5
Total.....	10	12	6	9	5	10	2	5
Rushes:								
Rush, Baltic.....	1	1	2	4	1	1	(1)	(1)
Other species.....	(1)	0	(1)	(1)	(1)	1	(1)	(1)
Total.....	1	1	2	4	1	2	(1)	(1)
Perennial weeds:								
Arnica, leafy.....	(1)	(1)	1	(1)	1	1	(1)	(1)
Aster, western.....	4	1	16	4	14	4	4	2
Bistort, American.....	0	0	0	0	0	0	0	0
Cinquefoils.....	(1)	(1)	9	5	14	9	7	8
Clover.....	1	(1)	6	8	2	3	1	3
Dandelion, common.....	(1)	(1)	2	3	5	8	10	28
Groundsels.....	1	(1)	8	3	14	5	2	1
Pussytoes.....					(1)	0	2	0
Waterleaf.....							9	0
Yarrow, western.....	(1)	(1)	3	1	7	4	11	10
Other.....	1	1	5	4	10	12	9	9
Total.....	7	2	50	28	67	46	55	61
Annual weeds:								
Gilias.....			0	0	0	0	0	0
Groundsmokes.....			0	0	0	0	0	0
Knotweed, Douglas.....			(1)	0	1	0	28	0
Lettuce, prickly.....							4	6
Tarweeds.....			0	0	0	0	0	0
Other.....	(1)	(1)	(1)	(1)	0	(1)	0	0
Total.....	(1)	(1)	(1)	(1)	1	(1)	32	6
Shrubs.....	(1)	(1)	(1)	0	0	0	(1)	(1)
All species.....	100	100	100	100	100	100	100	100

¹ Less than 0.5 percent.

The grazing capacity of meadows in very poor condition depends largely on the extent of the remaining perennial weeds and grasses. Most of the annual weeds and grasses are low in palatability to both sheep and cattle. The very thin stands of perennial species, including sedges and rushes, furnished 62 percent of the sheep forage and 80 percent of the cattle forage. Considerably different compositions of perennial species occur on individual meadows in very poor condition, but uniformly low density of these perennials results in little variation in the low grazing capacity.

JUDGING TRENDS IN MEADOW CONDITION

Mountain-meadow ranges deteriorate or improve according to the grazing treatment. If such ranges are to be managed effectively, a means should be provided to determine easily and quickly at proper intervals the effect of existing grazing on vegetation and soil. By observing the plant and soil indicators, the trend of range condition—whether upward or downward—can be recognized by field examination. Proper and timely adjustments in management may then be made.

Meadow vegetation does not change uniformly from one plant stage to another. Usually, the driest portions are the first to lose their good forage plants, and the last to regain them. Stage and rate of depletion depend somewhat on the amount of subirrigation. For example, on meadows that have partly deteriorated one may see small islands of vegetation typical of meadow range in good condition in the wettest areas, belts of vegetation common to fair-condition meadow range on moderately moist soils, and spots covered by annuals on the driest portions that signify very poor condition. Therefore, in judging trends, the places to watch as a rule are the drier areas, not the wettest. If good species appear to be spreading from wet to dry spots, the trend is undoubtedly up. If poor species are spreading from dry to wetter sites, the trend is down.

One should remember, however, that no single indicator can be used to establish the trend definitely. Thriftiness or weakness of valuable range plant species, presence or absence of their seedlings and young plants, arrangement of the plant colonies, and the nature and extent of erosion, all can be used as indicators of the trend in condition. Usually several indicators are present.

INDICATORS OF DOWNWARD TREND EVIDENCE OF DECLINE FROM GOOD CONDITION

The drier, better-drained spots of a productive mountain meadow show the first signs of deterioration. These places normally should be covered with vigorous tufted hairgrass plants having basal tufts up to 8 or 9 inches in diameter, leaves 8 to 10 inches long, and numerous shiny flower stalks 2 to 4 feet high. When the meadow begins to decline, the hairgrass stand on these well-drained areas loses its vigor and becomes thinned. Short, sparse basal leaves, low flower stalks, and a light-green color of the foliage are clues to low vigor in this species (fig. 11). Numerous dead plants and scarcity or lack of seedlings and young plants give further proof of deterioration.

Coincident with the gradual disappearance of tufted hairgrass is the occurrence of young, vigorous plants of such species as prairie junegrass, mountain brome, slender wheatgrass, and ovalhead sedge on the driest sites. Showy perennial weeds, including western aster, groundsels, cinquefoils, western yarrow, and leafy aster also actively invade the dry spots, as indicated by the presence of many young, thrifty plants. Colonization by perennial weeds of small, usually widely separated dry areas, gives rise to a patchy appearance.

Other earmarks of deterioration from good condition are: Kentucky bluegrass, thin bentgrass, red fescue, and California danthonia becoming

established on dry and moderately moist sites; the grass sod on the drier portions broken; and perennial grasses and sedges found on shoulders and sides of stream banks low in vigor and becoming thinned.

DECLINE FROM FAIR MEADOW CONDITION

As meadows deteriorate from fair to poor condition, there is a marked loss of vigor and further thinning of tufted hairgrass except in the wettest portions. There is also a colonization of the moderately moist localities by vigorous, showy perennial weeds, such as western aster, western yarrow, groundsels, cinquefoils, common dandelion, littleflower, penstemon, and American bistort. Young and fairly thrifty specimens of bunchgrasses, such as mountain brome, prairie junegrass, slender wheatgrass, timothy, and meadow barley, have become thinly mixed with the weeds



F-425351

FIGURE 11.—Tufted hairgrass plants of low vigor have a dwarfed appearance—evidence of range deterioration. Mature tufts produce few flower stalks, short basal leaves, and seldom exceed 3 to 4 inches in diameter. (Compare with figure 4.)

over a large part of the meadow. Weakened sod-forming grasses, such as thin bentgrass, Kentucky bluegrass, and red fescue, and Baltic rush, are only scattered throughout the perennial weed patches, or form narrow, but sometimes dense and thrifty belts—virtually free of weeds and bunchgrasses—around the remaining tufted hairgrass that occupies the wettest spots. An abundance of slender hairgrass and pullup muhly in moist depressions, especially if they surround old, isolated tufted hairgrass plants, is also a sign of deterioration from fair condition.

The driest localities have been converted to annual vegetation, with annual weeds such as Douglas knotweed, tarweeds, and groundsmokes in a prominent and thriving condition and perennial weeds and grasses sparse and weak. Invasion of the driest areas by dry-land perennials

such as subalpine needlegrass, big sagebrush, and silver sagebrush (fig. 12)—as evidenced by seedlings and young plants—also indicates deterioration, particularly when annual grasses such as cheatgrass and soft bromes are present.

Stream-channel cutting, barren, eroding stream banks, and fresh, unvegetated mud bars along the streams, as well as headward erosion of side gullies from main drainages, are certain signs of continued depletion (fig. 13).

MEADOWS NEARING BADLY DEPLETED CONDITION

When meadows deteriorate from poor condition, a general lack of vigor may be noted in virtually all perennials except slender hairgrass, which is unpalatable to cattle, and spring succulents, such as waterleaf



F-425336

FIGURE 12.—The invasion of silver sagebrush in a mountain meadow is a common indicator of downward trend.

and small bluebells, that escape grazing injury by drying and shattering early in the summer. Tufted hairgrass has usually been eliminated except in wet, swampy spots, the weak plants on the fringes of these areas being surrounded by slender hairgrass, annual hairgrass, weeds, and weakened, sparsely growing sedges, rushes, and perennial grasses. California false-hellebore, a tall and rather unpalatable weed, is often firmly entrenched in the moister places and gives shelter to small patches of weak Kentucky bluegrass, thin bentgrass, and Baltic rush.

Over the bulk of the meadow, annuals are generally aggressive and relatively abundant, and the remaining perennial weeds, chiefly western yarrow, common dandelion, pussytoes, and cinquefoils, exhibit a weakened condition and assume a matlike growth. Dandelion escapes much grazing by its growing habit, the leaves being flat on the ground. Onion-grass, normally an erect plant with few basal leaves, has weak flower stalks that spread out on the ground for some distance before ascending.



F-425331

FIGURE 13.—Stream-channel cutting, characterized by steep barren stream banks and overhanging and broken sod, indicates meadow deterioration.

Streams that are actively widening and deepening their channels, and the rapid development of side gullies by headward erosion, are further indications of continuing depletion.



F-425318

FIGURE 14.—The replacement of annuals by vigorous perennials indicates meadow improvement from very poor condition. Here groundsels, cinquefoils, and prairie junegrass are invading vegetation composed mainly of Douglas knotweed, groundsmokes, and gillias.

INDICATORS OF UPWARD TRENDS FROM VERY POOR CONDITION

The most obvious sign of improvement from very poor meadow condition is the establishment of young, thrifty perennials among the annual weeds and grasses (fig. 14). This usually consists of: (1) A major in-



F-425323

FIGURE 15.—Young plants of tufted hairgrass and thin bentgrass becoming established on a moist site. This is a sign of upward trend on meadows otherwise in very poor condition.

crease in vigor and density of such perennial weeds as agoseris, common dandelion, western yarrow, groundsels, cinquefoils, and littleflower pentstemon; and (2) scattered growth of new plants of tufted and grasslike species such as mountain brome, ovalhead sedge, and prairie junegrass, and small colonies of rootstock species such as Kentucky bluegrass, red fescue, thin bentgrass, Nebraska sedge, and Baltic rush.

Other indicators of meadow improvements from very poor condition are the establishment of young, thrifty tufted hairgrass plants in wet spots and the spread of mountain brome, Baltic rush, sedges, and tufted



F-425330

FIGURE 16.—Stream-channel stabilization by the establishment of sedges, rushes, and grasses, both on silt deposits and along stream banks, shows meadow improvement. This view is inside a grazed fenced plot a few hundred feet downstream from the area shown in figure 13.

hairgrass over denuded stream banks (figs. 15 and 16). On improving meadows, all vegetation appears vigorous and healthy. Often a temporary increase in vigor and abundance of annuals may occur under good management but they ordinarily give way to invading perennials.

FROM POOR CONDITION

An improvement from poor meadow condition is generally revealed by (1) a general thickening of young, thrifty tufted hairgrass plants near the wettest areas and scattered small plants of this species on drier sites; and (2) thrifty colonies of Kentucky bluegrass, red fescue, thin bentgrass, Baltic rush, and Nebraska sedge spreading among the weed patches and the stands of mountain brome, tufted-sedge species, and prairie junegrass. These sod-forming species usually form dense, pure patches with sharply defined boundaries (fig. 17). Nebraska sedge may show evidence of crowding out Kentucky bluegrass, red fescue, and thin bentgrass in moister areas. Eroded stream banks and side gullies are becoming stabilized by sedges, rushes, and tufted hairgrass, with only traces of mountain brome, ovalhead sedge, and prairie junegrass remaining (fig. 18).

HIGHER STAGES OF MEADOW IMPROVEMENT

General establishment and thickening of the tufted hairgrass on the driest as well as moister spots is one of the best signs that a meadow is approaching good range condition. Eventually the tufted hairgrass becomes so dense and vigorous that it largely replaces other grasses and weeds, especially tufted species like mountain brome, ovalhead sedge, and prairie junegrass. The perennial weeds, invaded by tufted hairgrass,



F-425320—425319

FIGURE 17.—Thin bentgrass spreading on a mountain meadow in poor condition on which the vegetation consists chiefly of groundsels, American bistort, agoseris, and Oregon checkermallow. The abrupt boundaries of the thin bentgrass colonies shown in A, as contrasted with B, are characteristic of invading sod-forming grasses.



F-413111

FIGURE 18.—Stabilization of side gullies by sedges and grasses is an indicator of the higher stages of meadow improvement. This may occur under proper grazing management when the meadow as a whole is still in poor condition, but improving.

thin bentgrass, or Kentucky bluegrass, lack their normal height, vigor, and brilliant bloom. Meadows nearing good condition, therefore, gradually tend to lose their uneven or patchily vegetated appearance. There are spots or clumps of vegetation outstandingly different in form or color from the surrounding tufted hairgrass cover. And eroded stream banks and recent silt deposits are completely stabilized by sedges, rushes, and tufted hairgrass.

PROPER MANAGEMENT OF MOUNTAIN MEADOWS

Management of mountain-meadow range to produce and utilize a maximum forage crop should unquestionably be designed to restore and maintain a thrifty stand of tufted hairgrass and other good perennial grasses. This should be the aim regardless of the present condition of the meadow. A meadow in fair condition, of course, will improve more rapidly than one in poor or very poor condition. Normally, however, the fertile, moist soils of mountain meadows make the attainment of good range conditions relatively easy under proper management. If the rancher or range operator judges the condition and trend of his mountain meadow range correctly, he can so stock the range and apply other range and livestock practices as to be assured of developing and maintaining the most productive range conditions. Such a policy, giving the proper emphasis to the management of both range forage and livestock, is the most successful in the long run.

By virtue of its high forage production, wide adaptability to altitude, latitude, and different soil-moisture conditions, and its ability to eliminate less desirable competitors, if given the chance, tufted hairgrass is the principal species that governs proper forage utilization and management of mountain meadows. Fifty-five percent removal of its herbage by

weight is about the proper degree of grazing for tufted hairgrass. Under this degree of utilization, it will generally maintain itself or increase in density. Such an intensity leaves an average leaf stubble of about 3 inches. Studies of sheep and cattle grazing on meadows throughout mountainous Oregon and Washington ranges indicate that the important associated meadow vegetation will normally be utilized rather moderately when 55 percent of the tufted hairgrass herbage is grazed (table 3).

The herbage of most grasses, other than tufted hairgrass, will be utilized 50 percent or less when the range as a whole is properly grazed by cattle. For example, approximately 40 percent of thin bentgrass, Cusick bluegrass, and prairie junegrass, and about 50 percent of mountain brome and slender wheatgrass will be utilized. Kentucky bluegrass and California danthonia are the only grasses eaten more freely than tufted hairgrass but are not abundant. Most of the weeds are only lightly grazed by cattle.

Sheep utilize several of the grasses and sedges found on mountain meadows almost as heavily as the tufted hairgrass. A number of weeds are grazed more freely than the grasses, including such important species as western aster, cinquefoils, and several which occur in limited stands.

For all these reasons, tufted hairgrass is the best species to observe in order to determine current use of meadows. Since it is desirable to maintain or increase the stand of tufted hairgrass, the meadow should be managed so that not more than 55 percent of the herbage of this species is utilized on the drier, more heavily grazed sites. If this is done it may

TABLE 3.—*Relative grazing value, or individual-species utilization for sheep and cattle*

Species	Meadow condition on which most abundant	Species utilization ¹ by—	
		Sheep	Cattle
		Percent	Percent
Arnica, leafy	Fair to poor	35	20
Aster, western	Fair	75	15
Bentgrass, thin	do.	20	40
Bluegrass, Cusick	Fair to poor	(2)	40
Bluegrass, Kentucky	do.	55	70
Brome, cheatgrass	Very poor	5	5
Brome, mountain	Poor to very poor	35	50
Brome, soft	Very poor	5	5
Buttercup	Fair	70	15
Checkernallow, Oregon	Poor	85	60
Cinquefoils	Fair to poor	80	30
Dandelion, common	Poor	40	50
Danthonia, California	Fair	40	70
Fescue, red	Good to fair	30	30
Groundsels	Fair to poor	50	15
Groundsmokes	Very poor	0	0
Hairgrass, annual	do.	0	0
Hairgrass, slender	do.	5	0
Hairgrass, tufted	Good	55	55
Junegrass, prairie	Poor	45	40
Knotweed, Douglas	Very poor	45	0
Muhly, pullup	Fair to very poor	5	5
Needlegrass, subalpine	Very poor	20	30
Penstemon, littleflower	Poor	70	25
Rush, Baltic	Fair	15	30
Sedge, Nebraska	Good	60	(2)
Sedge, ovalhead	Poor	40	45
Strawberry	do.	25	0
Waterleaf	Very poor	25	0
Wheatgrass, slender	Poor	40	50
Yarrow, western	do.	35	15

¹ Percentage of total weight of herbage produced by each species that is removed when meadows as a whole are properly grazed. The proper-use values or ratings for the above species are solely for meadow conditions. Proper-use ratings for many of the same species to cover other grassland and timber types would be somewhat lower.

² Insufficient data available.

safely be assumed that the remainder of the meadow vegetation is also used satisfactorily. On the other hand, there is danger of a downward trend in condition if tufted hairgrass utilization is consistently heavier than 55 percent on the drier portions of the meadow.

If the condition of the meadow is such that tufted hairgrass is limited to low, wet spots more or less avoided by livestock, other valuable plant species that occur in quantity on the drier, more heavily grazed sites may be used to determine the degree of meadow range utilization. Since perennial grasses and sedges are the class of vegetation most desirable to foster, the substitutes should be usually perennial grass or grasslike species.

For meadows in very poor condition mountain brome, Kentucky bluegrass, or other palatable perennial grasses or grasslike plants that are available, even as scattered specimens, may be used to determine current utilization. For meadows in poor condition—that support little tufted hairgrass—Kentucky bluegrass, thin bentgrass, slender wheatgrass, prairie junegrass, and tufted sedges are suggested as key species. Enough tufted hairgrass should occur on most meadows in fair condition to warrant using it as a key species. If there is not enough of it, thin bentgrass, Kentucky bluegrass, red fescue, or Cusick bluegrass are usually found in sufficient amounts to serve as substitutes.

Forage utilization should be considered proper if these substitute species on the drier spots have not been grazed in excess of the intensities listed in table 3. If heavier grazing occurs, tufted hairgrass and other desirable species characteristic of good meadow vegetation will not increase.

Meadows that have been seeded to cultivated species, such as smooth brome or redtop, should, of course, be managed on the basis of satisfactory utilization of these tame pasture grasses.

SEASON-LONG VS. ROTATION GRAZING

If an extensive cattle range that contains mountain meadows is subjected to constant grazing during the summer, the natural preference of livestock for lush forage is apt to result in closely grazed vegetation on the meadows throughout the growing period. If such a cattle range is grazed season long, it is extremely difficult, without special efforts to keep the animals distributed by means of water, salt, riding and fencing, to obtain a proper degree of forage utilization without reducing the numbers of livestock to the grazing capacity of the meadows alone. If the animals are not kept adequately distributed, the continued grazing of the tufted hairgrass plants gradually weakens them, few seedstalks are left ungrazed, and there is little opportunity for the establishment of new plants.

Some relief can be given mountain meadows where they are part of an extensive cattle range through the establishment of adequate watering facilities away from the meadows and placing salt on the outlying range, together with riding to keep the cattle from congregating on the meadows. Full use of nonmeadow vegetation on cattle range probably can never be attained without damaging the meadow forage unless meadows are fenced off. This is feasible only for very large meadows. However, cross-fencing the range and grazing the units under a rotated-deferred system will permit considerably more cattle to be grazed without injuring the meadows than would be the case under straight, season-long management.

Rotation grazing permits meadow vegetation to mature and to disseminate seed in the units scheduled for late-summer grazing. It also allows the plants on early grazed units to regrow and build up in vigor, undisturbed by grazing during the remaining growing season. Furthermore, under this system, the period of use is changed each year for each unit, so that none is grazed consistently early or consistently late. Rotation and deferment of mountain meadows should be a must on summer sheep ranges since the results are as beneficial as those secured on cattle range and no expenditure for fencing is needed.

Most effective use of meadow vegetation is made after the soil has become firm enough to withstand livestock trampling. Too early use of mountain meadows is not only wasteful, but sheep trample more forage than they eat on wet soils, while cattle punch up the soil and break the sod. Rotated and deferred grazing aids recovery from damage caused by early grazing. With grazing rotated on three or four units, early use occurs on only one-fourth or one-third of a range each year, and after the livestock move on to another unit, the early grazed portion can make undisturbed growth.

AVOIDANCE OF UNDUE LIVESTOCK CONCENTRATION

Undue concentration of livestock is a principal cause of meadow deterioration. Sheep often are bedded for several nights in one spot and cattle are sometimes salted at permanent salt grounds at meadow edges. Either practice, if followed for a few years, will lower the condition of an appreciable surrounding area of meadow vegetation. Moreover, zones of deterioration, heaviest at the bed ground or salt ground and lightest at the perimeter, extend outward into the meadow. It is not unusual to see several acres reduced from a good to a poor condition by persistent bedding in one locality. As vegetation conditions get worse at the bed or salt ground, the zone of deterioration tends to work outward, and poor conditions intensify within the zone so that eventually the entire meadow may be affected. The consequent grazing loss is great.

Sheep should always be bedded off the meadows on higher adjacent ground, unless topography, dense thickets, or other factors make it impossible. If the sheep cannot be taken off the meadow they should be bedded in a different spot each night. Placing salt grounds away from meadows in areas where forage utilization is normally light will aid in protecting the meadows and obtaining proper grazing distribution on cattle range.

NEED FOR SUBIRRIGATION

Ample subirrigation plays a vital part in maintaining high forage production. The heavy plant cover in turn checks runoff and permits maximum penetration of precipitation. On the other hand, destruction of plant cover permits rapid runoff which may cause gullying. Excessive draining by a gully system is an important cause of further meadow deterioration. Since beaver dams tend to hold water at a high level in stream channels, the removal of beaver colonies and destruction of their dams can be the initial cause of stream-bank erosion and draining of meadows. Another common cause of draining is the excavation of ditches to provide adequate drainage for roads. Unnecessary or unsound

road construction or needless beaver extermination on meadows therefore should be avoided.

BENEFITS FROM PROPER MEADOW MANAGEMENT

If the summer range is so managed that good mountain-meadow conditions are maintained or the trend is constantly upward, the rancher is assured of an adequate supply of choice summer forage for finishing the sheep and cattle he is grazing. There will, of course, be far greater abundance of choice summer forage on a range in good condition than on ranges below such condition. The amount of forage, as indicated earlier, is extremely limited on ranges in very poor condition. In eastern Oregon and Washington, managing mountain meadows to maintain them in good condition or to keep their trend upward, in contrast to heavy grazing that would cause deterioration, sometimes amounts to the difference between marketing feeders or grass-fat animals. This may be the difference between economic security or financial distress to the livestock operator. The more abundant the forage and the better its quality, the more assurance he has of sustaining stable production of high-quality meadow forage and high-quality animals.

COMMON AND BOTANICAL NAMES OF SPECIES MENTIONED

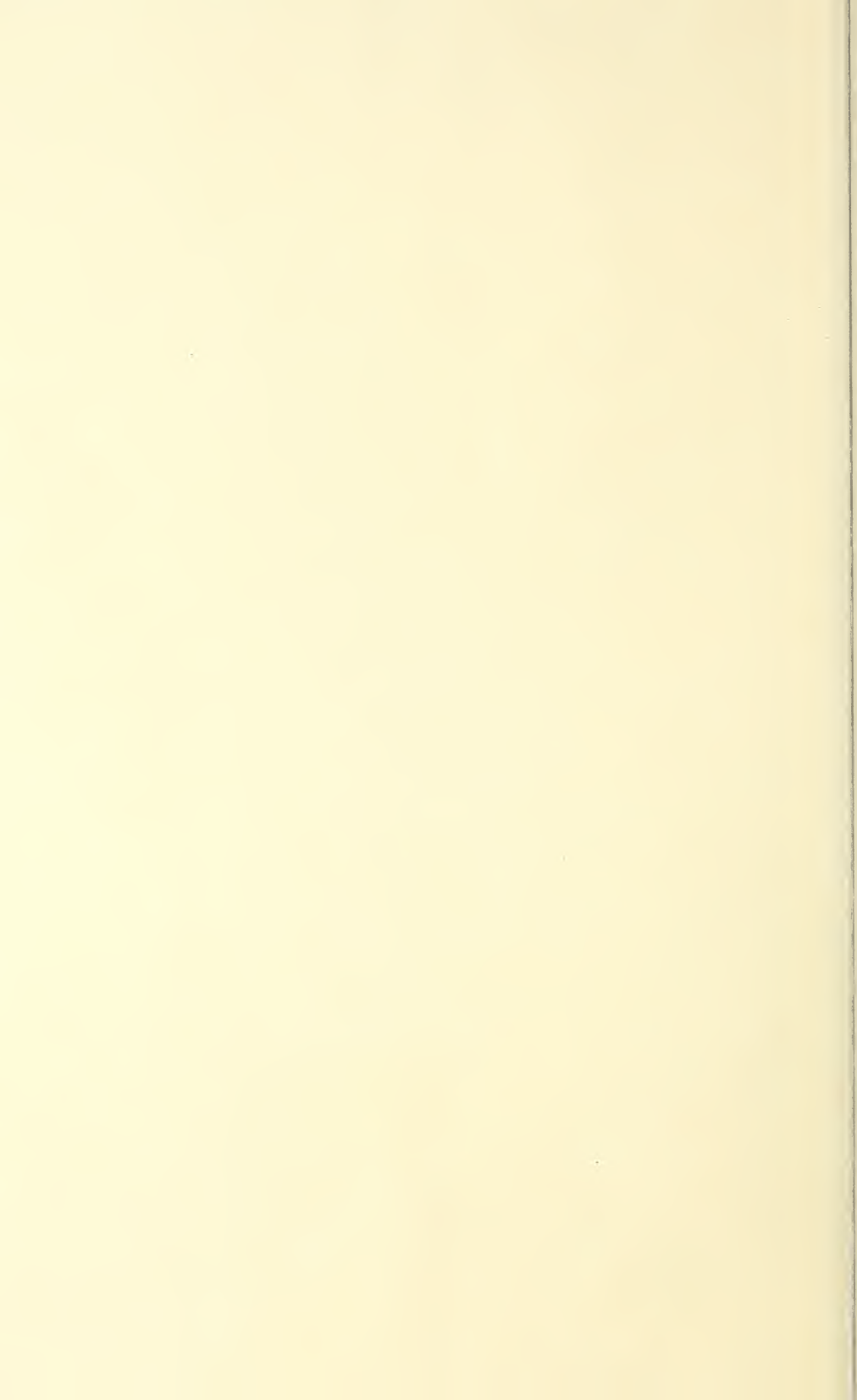
Grasses:

Barley, meadow	<i>Hordeum nodosum</i>
Bentgrass, thin	<i>Agrostis diegoensis</i>
Bentgrass, winter	<i>Agrostis scabra</i>
Bluegrass, Cusick	<i>Poa cusickii</i>
Bluegrass, Kentucky	<i>Poa pratensis</i>
Bluegrass, Sandberg	<i>Poa secunda</i>
Brome, cheatgrass	<i>Bromus tectorum</i>
Brome, mountain	<i>Bromus carinatus</i>
Brome, smooth	<i>Bromus inermis</i>
Brome, soft	<i>Bromus mollis</i>
Danthonia, California	<i>Danthonia californica</i>
Fescue, red	<i>Festuca rubra</i>
Hairgrass, annual	<i>Deschampsia danthonioides</i>
Hairgrass, slender	<i>Deschampsia elongata</i>
Hairgrass, tufted	<i>Deschampsia caespitosa</i>
Junegrass, prairie	<i>Koeleria cristata</i>
Muhly, pullup	<i>Muhlenbergia filiformis</i>
Needlegrass, subalpine	<i>Stipa columbiana</i>
Oniongrass	<i>Melica bulbosa</i>
Redtop	<i>Agrostis alba</i>
Timothy	<i>Phleum pratense</i>
Wheatgrass, slender	<i>Agropyron trachycaulum</i>

Grasslike plants:

Bulrushes	<i>Scirpus</i> spp.
Cattail, common	<i>Typha latifolia</i>
Rush, Baltic	<i>Juncus balticus</i>
Sedge, Nebraska	<i>Carex nebraskensis</i>
Sedge, ovalhead	<i>Carex festivella</i>
Sedge, water	<i>Carex aquatilis</i>



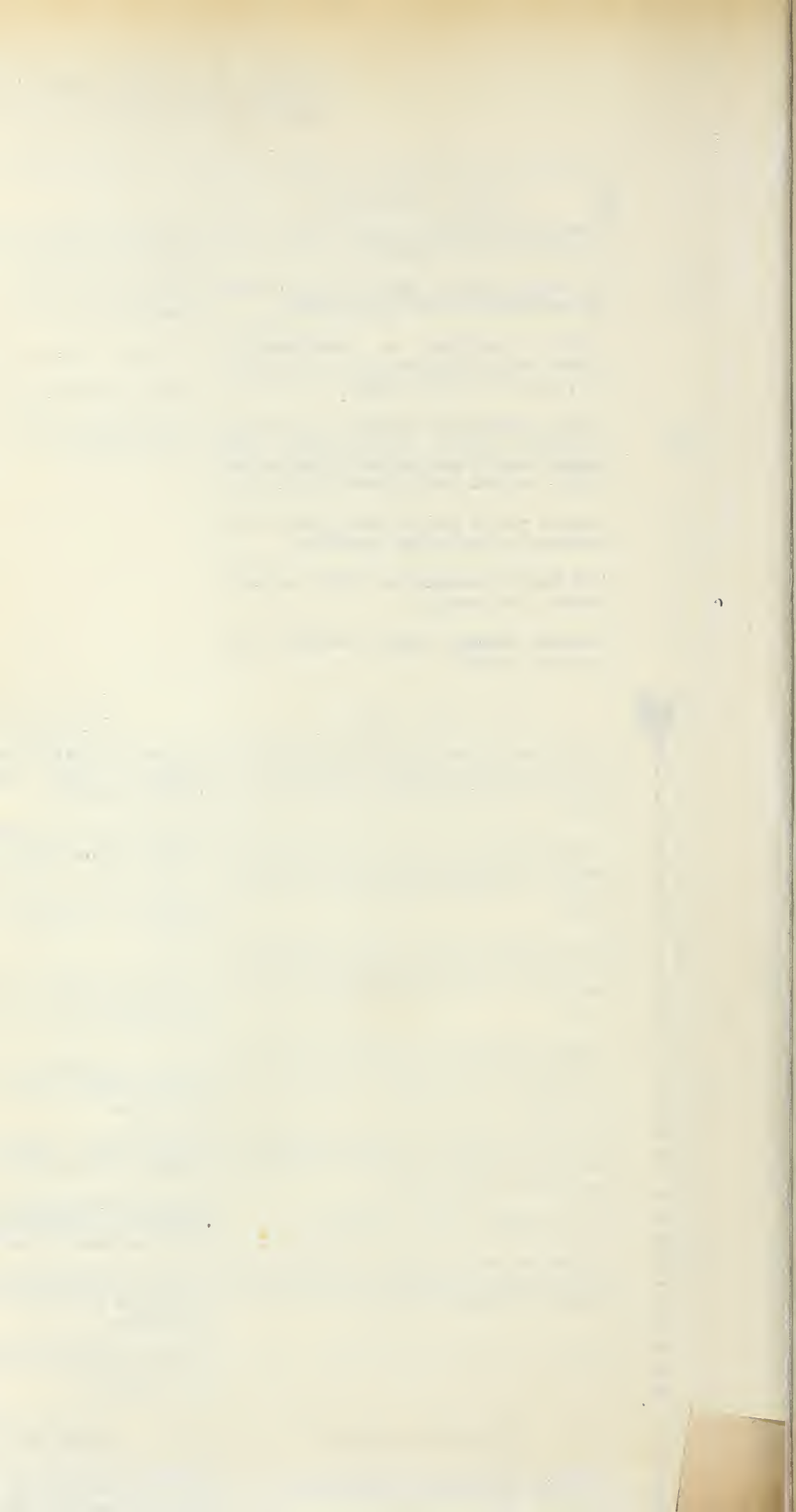


GUIDES TO DETERMINE RANGE CONDITION AND TREND OF MOUNTAIN-MEADOW VEGETATION

RANGE DETERIORATION

RANGE IMPROVEMENT

<p>GOOD CONDITION</p> <p>Vegetation dense, covers about two-thirds of ground surface.</p> <p>Perennial grasses make up more than three-fourths of the vegetation.</p> <p>Tufted hairgrass is predominant; grows on dry and wet soils; furnishes 80 percent of the forage.</p> <p>Finely intermixed specimens of other perennial grasses, weeds, sedges, and rushes hardly noticeable; meadow not highly colored during flowering season.</p> <p>Annual weeds and annual grasses not present in noticeable amounts.</p> <p>Soil highly productive, rich in organic matter; no erosion.</p> <p>Grazing capacity about one-half acre per cow month.</p>	<p>(From Fair to Good)</p> <p>Increasing stands of palatable grasses, especially tufted hairgrass, which is thickening and becoming established on driest sites as well as moister areas.</p> <p>Grass stand gaining appearance of even cover on meadow; patchiness becoming indistinct.</p> <p>Perennial weeds and secondary grasses show weakened vigor.</p> <p>Considerable dead herbage material, forming some litter.</p> <p>Stream-bank erosion rapidly arrested, eroded side drainages choked with vegetation and stabilized.</p>	
<p>(From Good to Fair)</p> <p>Thinning and loss of vigor of tufted hairgrass stand especially on driest spots; other localized breaking of sod on dry sites.</p> <p>Establishment of young thrifty tufted plants of ovalhead sedge, prairie junegrass, and California danthonia on these spots.</p> <p>Sod-forming grasses, such as Kentucky bluegrass, red fescue, and thin bentgrass, spreading on dry and moderately moist areas.</p> <p>Many young plants of weeds such as Columbin groundsel, western yarrow, western aster, and cinquefoils coming in on dry sites.</p> <p>Vegetation taking on patchy appearance. Bare spots showing on shoulders of stream banks and on driest spots.</p> <p>Stream-bank erosion beginning.</p> <p>Utilization of more than fifty-five percent of tufted hairgrass herbage at the end of the grazing season.</p>	<p>FAIR CONDITION</p> <p>Vegetation rather dense, but somewhat patchy; covers about one-half of ground surface.</p> <p>Amounts of perennial weeds and perennial grasses about equal.</p> <p>Meadow shows brilliant colors blended with green during the flowering season.</p> <p>Tufted hairgrass usually most abundant grass; dense on wet soils, sparse on drier areas; on the average covers about one-tenth of ground surface.</p> <p>Other perennial grasses, perennial weeds, tufted sedges abundant on driest areas.</p> <p>Sod-forming grasses, sedges, and rushes in dense patches.</p> <p>Annual grasses and annual weeds generally not noticeable, but may be found on small denuded and dry spots.</p> <p>Driest spots and stream banks if trampled have unstable soil often not fully productive.</p> <p>Grazing capacity about one acre per cow month.</p>	<p>(From Poor to Fair)</p> <p>General increase in palatable weeds and grasses.</p> <p>Thickening of young healthy tufted hairgrass plants near wettest areas, their encroachment into Kentucky bluegrass, red fescue, and thin bentgrass stands on moist sites, and scattered invasion even on drier areas.</p> <p>Thrifty Kentucky bluegrass, red fescue, Nebraska sedge, and thin bentgrass invading colonies of perennial weeds, mountain brome, ovalhead sedge, and prairie junegrass.</p> <p>Annual weeds declining in abundance. Stream banks stabilized by sedges, rushes, and tufted hairgrass, traces of mountain brome, ovalhead sedge, and prairie junegrass remaining on stream banks.</p>
<p>(From Fair to Poor)</p> <p>Further thinning of vegetative cover as a whole; increasing in patchiness.</p> <p>Marked loss of vigor of tufted hairgrass, thinning even on relatively moist areas.</p> <p>Other palatable grasses losing vigor and thinning.</p> <p>Almost worthless slender hairgrass and pullup mully coming in on wet spots.</p> <p>Perennial weeds invading moist meadow portions; increasing abundance of such weeds as dandelion and yarrow.</p> <p>Vigorous annual weeds, such as tarweeds, Douglas knotweed, and groundsmokes increasing on dry areas.</p> <p>Burien, eroded stream banks, channeling obvious; headward cutting of side drainages.</p> <p>Utilization of herbage of tufted hairgrass and other palatable plants well in excess of half that produced.</p>	<p>POOR CONDITION</p> <p>Vegetation often rather thin; distinctly patchy in appearance; on the average covers about one-third of ground surface.</p> <p>Tufted hairgrass limited to wet places. Perennial weeds covering about one-sixth of the ground surface are luxuriant over most of the meadow and twice as abundant as perennial grasses; meadow very colorful during flowering season.</p> <p>Other grasses, sedges, and rushes in evidence, mixed with perennial weeds.</p> <p>Annual plants abundant on small denuded areas on driest meadow soils.</p> <p>Considerable bare soil; sometimes compacted and deficient in organic matter, often loose and worked by rodents.</p> <p>Stream erosion noticeable; some side gullies.</p> <p>Grazing capacity about two acres per cow month.</p>	<p>(From Very Poor to Poor)</p> <p>Perennial plant cover thickening; vigorous, healthy growth; perennial weeds such as dandelion, agoseris, yarrow assuming upright rather than ground-hugging form.</p> <p>Scattered establishment of tufted and grasslike plants such as mountain brome, prairie junegrass, ovalhead sedge.</p> <p>Small spots of rootstock species such as Kentucky bluegrass, thin bentgrass, red fescue, and Balise rush, spreading in patches of annual and perennial weeds.</p> <p>Young, thrifty tufted hairgrass plants becoming established near streams and other wet places.</p> <p>Grasses and rushes spreading on denuded stream banks and eroded side drainages.</p>
<p>(From Poor to Very Poor)</p> <p>Marked thinning of vegetative cover.</p> <p>Slender hairgrass and annual grasses such as soft brome, pullup mully, cheatgrass brome, and annual hairgrass, vigorous and spreading over most of meadow.</p> <p>Vigorous extension of annual weeds such as tarweeds, Douglas knotweed, and groundsmokes over extensive areas, even surrounding old perennial-grass plants.</p> <p>General lack of vigor in valuable perennial plants, yarrow growing in clumped, turl-like form, and dandelion prostrate with few erect leaves.</p> <p>Much loose, exposed, and compacted soil; often evidence of erosion on meadow. Stream channeling serious; rapid headward erosion on small side drainages.</p>		<p>VERY POOR CONDITION</p> <p>Vegetation sparse; only one-tenth of ground covered.</p> <p>Annual weeds and annual grasses most abundant vegetation.</p> <p>Tufted hairgrass present only as occasional plants in wettest places; sod-forming grasses, sedges, and rushes scarce.</p> <p>Perennial weeds often common.</p> <p>Slender hairgrass, or other low-value grasses, sometimes prominent.</p> <p>On drained meadows dry-land vegetation, such as big sagebrush, sometimes present.</p> <p>Soil ordinarily exposed, compacted, and lacking in organic matter; bakes and cracks when it dries.</p> <p>Erosion serious; stream channels often cut deeply; side gullies extensive.</p> <p>Grazing capacity about 10 acres per cow month.</p>



Weeds:

Agoseris	Agoseris spp.
Arnica, leafy	Arnica foliosa
Aster, western	Aster occidentalis
Bistort, American	Polygonum bistortoides
Bluebells, small	Mertensia longiflora
Buttercups	Ranunculus spp.
Checkermallow, Oregon	Sidalcea oregana
Cinquefoils	Potentilla spp.
Clovers	Trifolium spp.
Dandelion, common	Taraxacum officinale
False-hellebore, California	Veratrum californicum
Gilias	Gilia spp.
Groundsel, Columbia	Senecio columbianus
Groundsels	Senecio spp.
Groundsmokes	Gayophytum spp.
Knotweed, Douglas	Polygonum douglasii
Lettuce, prickly	Lactuca scariola
Penstemon, littleflower	Penstemon procerus
Pussytoes	Antennaria spp.
Sorrel, sheep	Rumex acetosella
Strawberries	Fragaria spp.
Tarweeds	Madia spp.
Waterleaves	Hydrophyllum spp.
Wyethias	Wyethia spp.
Yarrow, western	Achillea lanulosa

Trees and shrubs:

Pine, ponderosa	Pinus ponderosa
Sagebrush, big	Artemisia tridentata
Sagebrush, silver	Artemisia cana

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For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C.—Price 10 cents

